A Vision for Future Virtual Training

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ABSTRACT

Virtual training is not intended to replace live training; it augments and supplements live training to sustain unit proficiency. The many advantages of virtual training are currently limited by lack of full interoperability with other virtual simulations, Live and Constructive training environments and battle command systems. In addition, the synthetic environment replicated in virtual training does not accurately represent the actual area of operations or local training areas. Army programs such as Synthetic Environment Core (SE Core), the Future Combat System (FCS), and the Live, Virtual, Constructive – Integrated Architecture (LVC-IA), along with science and technology initiatives, will greatly increase the capabilities and interoperability of the virtual training environment, resulting in a more accurately replication of the operational environment. The impacts of these programs on virtual training simulations lead to a proposed updated vision for future virtual training.

1.0 INTRODUCTION

The Defense Modeling and Simulation Office defines virtual training as "a simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a C4I team)."[1]

Virtual simulations are intended to augment, not replace live training. This is reiterated in FM 7-0, Training the Force, which states: "Virtual and Constructive training cannot replace all live training. They can, however, supplement, enhance and complement live training to sustain unit proficiency within the Band of Excellence."[2] Virtual simulations provide commanders another means to improve readiness and conduct mission rehearsals within the *crawl-walk-run* training approach. Units deploying to Operation Iraqi Freedom, for example, have used the Close Combat Tactical Trainer (CCTT) to train and establish tank and mechanized platoons training readiness. Non-mechanized units have used the Virtual Combat Convoy Trainer (VCCT) to train on unit convoy procedures using simulated Iraqi terrain. Soldiers throughout the Army have used the EST2000 system to achieve and maintain marksmanship proficiency on their assigned weapons.

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[1] Online M&S Glossary (DoD 5000.59M), United States Department of Defense, Defense Modeling and Simulation Office, accessed on 30 March 2006, <www.dmso.mil/public/resourses/glossary/>.

[2] Headquarters Department of the Army Field Manual (FM) 7-0, Training the Force, October 2002, 4-15.

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Virtual training offers many advantages over live training. Virtual training has no restraints on ammunition and fuel. Prior to a firing on live fire range, for example, an Abrams tank or Apache attack helicopter crew can fire unlimited amounted of virtual munitions in the virtual training environment, allowing them to meet preparatory training proficiency objectives *virtually* while minimizing the use of costly live ammunition. In addition to saving money, virtual training allows units to safely train dangerous tasks, such as call for fire and close air support. Virtual training has no environmental restrictions and, through its use of virtual terrain databases (TDB), provides unlimited access to multiple maneuver areas, unconstrained by training boundaries or real-world populated areas. Finally, virtual training can quickly incorporate real-life lessons learned from combat environments into virtual training scenarios, providing realistic contemporary enemy actions and reactions to increase training realism and relevancy. These scenarios can start simply and then progressively increase in difficulty to train more adaptive and innovative Soldiers and leaders.

Current virtual simulators and simulations are successfully used to train individual tasks, crew drills and collective and combined arms tasks using a synthetic environment. A limitation of today's virtual training environment is the lack of full interoperability between virtual simulators (e.g., CCTT and VCCT), between training environments (Live, Virtual and Constructive [LVC]) and between training domains (Institutional, Self Development and Operational, which include home stations, deployed locations and combat training centers [CTC]). Future Combat System (FCS) training capabilities, along with the Live, Virtual, Constructive – Integrated Architecture (LVC-IA) and the Synthetic Environment Core (SE Core) programs, will eliminate many of these shortfalls, leading to a training environment that more closely replicates the operational environment. Through a variety of technological developments, development of common standards and protocols, and production of common virtual components, such as correlated TDBs, these three programs will expand the virtual battle space, increasing the utility of virtual training in the future.

2.0 CURRENT STATE OF VIRTUAL TRAINING

Current virtual training capabilities are often described as "stove-piped" because today's virtual simulations were developed independently and are not easily interoperable. SE Core is the key virtual program for enabling a common virtual training environment. The current virtual vision is centered on the SE Core program's successful development of a common virtual environment (CVE) and creation of standard linkages into the LVC-IA.

2.1 Today's Virtual Training Capabilities

The Army uses virtual system and non-system simulators and simulations to train Soldiers on individual tasks and crew drills and units on collective and combined arms tasks. Virtual training uses a computer-generated operational environment where Soldiers receive hands-on training operating simulated Army systems. Virtual simulators and simulations provide stimuli for the Soldier to increase cognitive and motor skill interaction while receiving real-time performance feedback. Virtual simulators create simulated warfighting conditions and provide Semi-Automated Forces (SAF) to enhance realism without using costly resources or time, thus providing resource efficient training.

Virtual training scenarios can be simple, supporting untrained (U) level training, increasing intensity for needs-practice (P) level training. Battalion level units attain and sustain warfighting proficiency and develop soldier field craft primarily through live training. In general, commanders at battalion level and lower plan and execute standards based training with virtual simulations to:

- Prepare for live training,
- Rehearse selected staff and unit battle tasks and squad, team and crew drills, and
- Retrain on selected unit battle tasks, supporting squad, team and crew critical tasks, and leader and individual soldier tasks evaluated as either P or U.[3]

A limitation of current virtual trainers is the difficulty of linking together systems developed in different virtual programs, when linkage is required to expand the training audience and provide for combined arms training. For example, while CCTT supports mechanized infantry and armor unit training by linking M1 and M2 simulators together, allowing units to conduct collective training events up to the battalion task force level, CCTT cannot be easily linked to other virtual simulators and simulations like the Aviation Combined Arms Tactical Trainer (AVCATT). In addition, virtual simulators and simulations do not link with units conducting live or constructive training.

2.2 SE Core Overview

SE Core is the Army's virtual component of the LVC-IA. It will create the Army's CVE by developing and integrate existing and new simulation hardware and software products. The CVE, enabled by SE Core, will connect virtual system and non-system simulators and simulations into a fully integrated virtual training capability and will enable Soldiers/units training in the Virtual training environment to link with Soldiers and units training in the Live and Constructive training environments through LVC-IA.

SE Core will integrate OneSAF Objective Systems (OOS) into CCTT and AVCATT. In addition, SE Core will provide the following components used by virtual simulations: rapidly developed and correlated TDB; dynamic terrain; atmospheric effects; Chemical, Biological, Radiological, Nuclear and High Explosive effects; common visual models; contemporary operational environment (COE) compliant training support packages (TSPs); net-ready capabilities; long-haul networking; and an integrated After Action-Review (AAR). These common components will be held in a repository, the Virtual Simulation Architecture (VSA), for quick reach-back when needed for virtual training. Soldiers and leaders will be able to access this repository in any domain (Institutional, Operational, and Self Development) through the Fixed Tactical Internet (FTI), Joint Training and Experimentation Network (JTEN) backbone, and the Global Information Grid (GIG).

Through common TDB, SAF and the standard components listed above, SE Core will provide the infrastructure or "backbone" for all virtual simulators and simulations and FCS embedded simulators. This backbone of components developed by SE Core will allow units to train collectively in joint and combined arms training events using wide area networks to link geographically dispersed simulations. In addition, they will see the same correlated synthetic terrain, fight a common SAF, and participate in a universal AAR. FCS will integrate the backbone of common virtual components developed by SE Core, making interoperability between current virtual trainers and future FCS embedded and stand-alone virtual trainers possible.

TDBs are an integral element of virtual training. Current virtual TDBs represent only about one half of one percent of the Earth's total land mass, due, primarily, to high production costs and lengthy development time. The SE Core program will resource research to develop a rapid TDB generation capability in order to decrease production costs and timelines. The SE Core program threshold is to produce a correlated virtual TDB within 96 hours, with an objective value of 72 hours. Rapid TDB generation will allow the military to quickly

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[3] Ibid.

produce TDB's within days vice months at a much lower cost than current databases. This capability will allow the Army to develop TDBs to support training at home stations and in support of contingency operations. More importantly, SE Core will develop correlated TDBs, consumable by training simulators, simulations and instrumentation systems in the LVC training environment (LVC-TE). Figure 1 depicts the concept for SE Core TDB development.
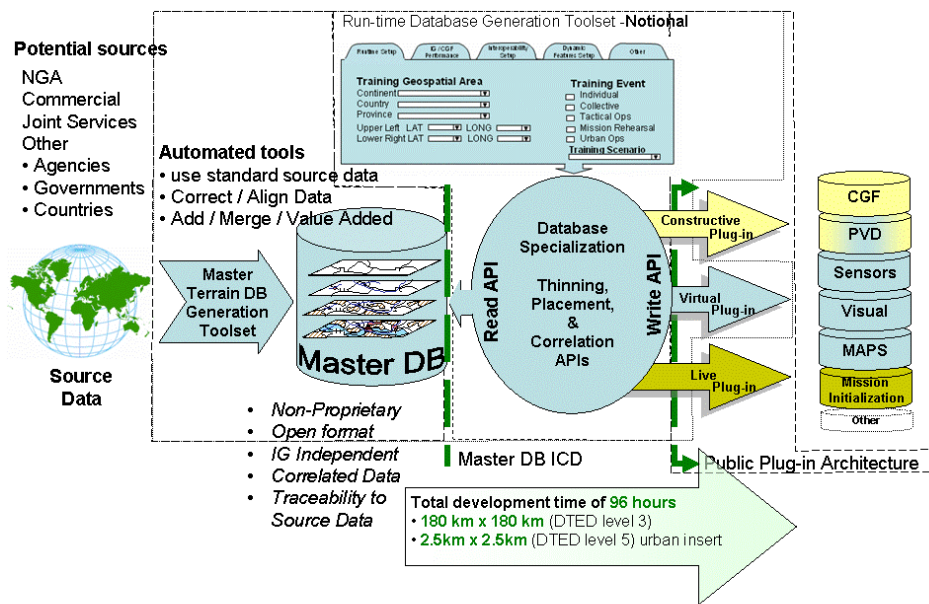

Figure 1: SE Core TDB Generation Concept.

2.3 Current Virtual Vision

By 2020, Army tactical commanders will use a networked family of virtual training simulations, within an integrated joint, Live - Virtual - Constructive training environment, to fully support their requirements to build and sustain training, develop leaders and conduct mission rehearsals enabling greater combat readiness.

3.0 FCS TRAINING CONCEPT

Key Performance Parameter (KPP) Six of the FCS Operational Requirements Document is Training. KPP Six threshold states: "The FCS Family of Systems (FoS) must have an embedded individual and collective training capability that supports live, virtual and constructive training environments."[4] The foundation of the FCS training concept is a fully embedded training (ET) capability. ET is an integral part of the FCS FoS design. FCS ET includes a fully embedded virtual training capability for individual, crew, leader, unit training and individual/crew training on FCS platforms using FCS operational interfaces (e.g., System of Systems Common Operating Environment [SoSCOE]).

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[4] FCS Overview, United States Army Web Page, accessed on 13 April 2006, <www.army.mil/fcs/factfiles/overview.html>.

3.1 FCS ET

The FCS network will facilitate the Soldier's ability to train anywhere and anytime using equipment on hand. ET must provide full task training capabilities and support operations, training, and mission planning and rehearsals of Soldiers, small units, leader/staff teams and dismounted infantry simultaneously without reconfiguring the equipment. ET will be developed as an integral part of the FCS manned platforms and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) architectures.

An embedded LVC training capability is the cornerstone of networked ET and will satisfy KPP Six. FCS ET must have the capability to combine LVC operations with SAF to reflect the operational environment. Virtual ET will be an onboard tactical engagement simulation system capable of using SAF for expanding the battlefield entity count (blue, red and undecided).

Finally, FCS FoS must have sufficient memory onboard FCS platforms to hold a repository of training products, AAR capabilities, and assessment and training management systems to enable ET. Through communication nodes, FCS must also be able to reach back to robust repositories like SE Core's VSA for additional training products such as correlated TDBs and common moving models. Future Force ET concept is shown in Figure 2.
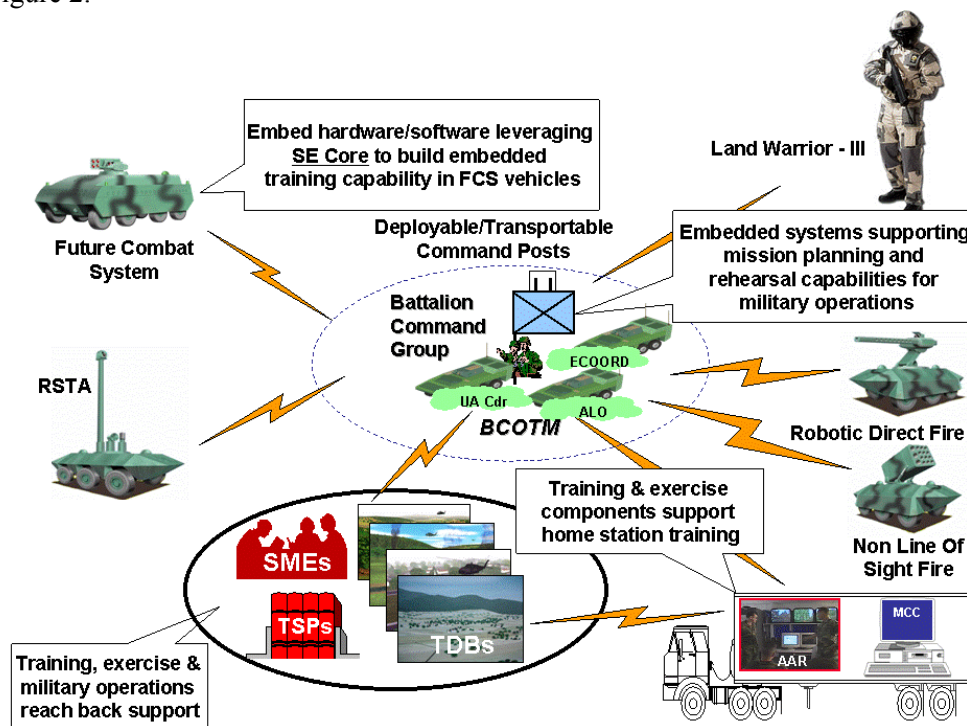

Figure 2: Future Force ET Concept.

3.2 FCS Interoperability and Institutional Training

FCS FoS will be interoperable with Current Force and Joint, Interagency, Intergovernmental, and Multinational (JIIM) platforms. FCS networks and information systems must conform to common architectures such as High Level Architecture, Joint Technical Architecture and Army Training Information

Architecture to ensure this interoperability. FCS will also establish resource centers at each branch school to provide 24/7 training and training support and reach back repositories. Training information held in these repositories must comply with Department of Defense (DoD) and Army standards for the design, development, and delivery of training products to include multimedia and other distance learning requirements. Training interoperability will be further achieved through interfaces between and among FCS systems and Future and Current Force simulations and by using SE Core components.

FCS will provide stand-alone Training Aids, Devices, Simulations and Simulators (TADSS) for those tasks not supported by the FCS ET capability or are required by training institutions in lieu of actual FCS platforms. FCS will accomplish this by fielding Networkable Reconfigurable Full-Task Trainers (NRFTT) and Part-Task Trainers (PTT) at training institutions for initial training on the system. These stand-alone trainers must be interoperable with FCS ET and Current Force TADSS. In addition, FCS must be capable of conducting seamless LVC training using 3D digital TDBs for training and operations. Therefore, FCS supports the efforts of SE Core and LVC-IA and has designated them as complimentary systems to the FCS program.

3.3 Spin Out Capabilities

The FCS-equipped Brigade Combat Team (BCT) will consist of three FCS-equipped Combined Arms Battalions, a Non-Line-of-Sight Cannon Battalion, a Reconnaissance Surveillance and Target Acquisition Squadron, a Forward Support Battalion, a Brigade Intelligence and Communications Company, and a Headquarters Company.

The Army has deemed FCS as the fastest way to modernize the force. Therefore the Army will accelerate fielding of select FCS capabilities (called Spin Outs) to reduce operational risk to the Current Force. Just as the emerging FCS capabilities enhance the Current Force, the Current Force's operational experience informs the FCS program, further mitigating future challenges, force management, and program risks. The plan adds four discrete Spin Out capabilities at two year increments for the Current Forces.

Spin Out 1 (SO1) will begin fielding in 2008 and consist of prototypes fielded to the Evaluation BCT. Following successful prototype evaluation and production of SO1 capabilities, fielding to the Current Force begins in 2010. This process will be repeated for each successive Spin Out. By 2017, the FCS program will meet Full Operation Capability (FOC). The force structure of the Army at this time will include two BCTs equipped with FCS core systems and ET capabilities. By 2025, only 15 of the 70 BCTs in the Army will be FCS-equipped units. The 55 non-FCS-equipped BCTs in the Army, added to the additional 111 brigade size units in the Army (e.g., Combat Support, Combat Service Support, Combat Aviation, and Fires) make up the preponderance of the total force structure in 2025. This fact leads to the realization that today's stand-alone virtual simulators and simulations will continue to be operational beyond 2025. Not all TADSS will be embedded and non-FCS-equipped units will have limited embedded and appended training capabilities. For that reason, the Army must ensure ET technologies are interoperable with current and future TADSS.

4.0 LIVE, VIRTUAL, CONSTRUCTIVE – INTEGRATING ARCHITECTURE AND INFRASTRUCTURE

The synthetic training environment is defined as: "The evolution of expanding battlespace to accommodate the use of digitization, to include M&S capabilities, within the Live, Virtual, Constructive training environment (LVC-TE) in support of combat readiness."[5] The LVC-IA program will enable development of a

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[5] TRADOC Regulation 350-70, 9 March 1999, accessed on 14 April 2006, <www.tradoc.army.mil/tpubs/regs/ r350-70/350_70_ii_12.htm#II-12-2>

LVC-TE. LVC-IA is a network-centric linkage that collects, retrieves and exchanges data among LVC components. This capability will include the ability to network with other Services' (e.g., USAF Distributed Mission Operations or USN Battle Force Tactical Trainer) and joint LVC capabilities in order to create a high-fidelity synthetic training environment.

4.1 LVC-IA Training Concept

The advent of digital battle command systems dictate that commanders, leaders, battle staffs, and units use their operational battle command (BC) systems for training and mission planning and rehearsals. The current training environment consists of LVC simulations, simulators, and instrumentation systems that were not developed to interoperate with each other, nor link to battle command systems. The integration and linking of LVC training simulations with operational battle command systems results in the training and mission planning and rehearsal environment termed the LVC-TE.

Standardizing LVC simulators, simulations and instrumentations data creates the conditions where units can train and rehearse mission essential tasks to standard in order to gain and maintain increased unit combat readiness. The Army LVC-IA will support the Joint LVC - Training Environment (JLVC-TE) and the Joint National Training Capability (JNTC). The LVC-IA will facilitate increased unit competency in preparation for operating in a JIIM environment. The creation of this holistic battlespace will produce units that are competent in Joint Command and Control (JC2) principles and capable of achieving success across the full range of military operations. The LVC-IA Operational View 1 in Figure 3 shows the relationship between LVC-IA, SE Core, the other training environments and Net Enabled Command Capability.
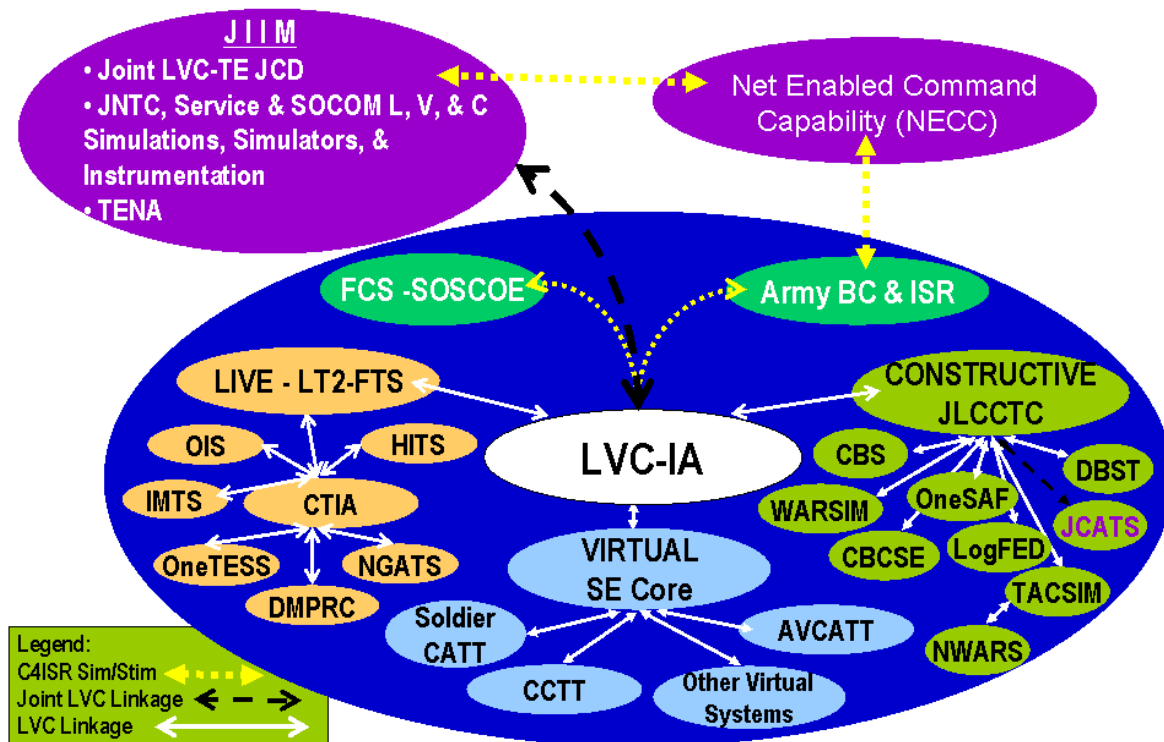

Figure 3.

LVC-IA will enable a *"plug-and-train"* capability for units training in any domain or environment. LVC-IA will rely on a robust communication network at home stations, CTCs and in operational environments. The JTEN, FTI, GIG and Warfighter Information Network – Tactical will provide the necessary bandwidth to move large packets of training data required for training and mission planning and rehearsals. Units will reach back to access large volumes of training data using standards and protocols developed by LVC-IA into repositories developed by SE Core, LVC-IA, and FCS. Access to training support data will allow unit commanders to quickly develop scenarios using rapidly developed correlated TDBs resembling the mission area (geo-specific terrain) for training and mission planning and rehearsals anywhere in the world.

To train using the LVC-IA capability, units will execute their mission as dictated by the simulated scenario and interact with elements that comprise the COE. By integrating LVC simulators, simulations and instrumentation systems, the conditions are created to enable mission planning and rehearsals and training of essential tasks to standard to gain and maintain unit readiness. The results solidify the unit's skills with practical simulated warfighting training.

5.0   VIRTUAL TRAINING TRENDS / TECHNOLOGY

Current virtual simulators and simulations are divided into air and ground system and non-system trainers. System trainers are designated for specific combat systems while non-system trainers are virtual trainers that are not associated with a specific Army system. The Army's Longbow Crew Trainer is an example for an air system trainer where AVCATT is an example of an air non-system trainer. Current system and non-system training devices are highly structured, proprietary and specialized solutions with minimal interoperability and provide a general synthetic training environment (geo-typical terrain).

Over the next 25 years, virtual training solutions will evolve to become more reconfigurable to represent several Army systems. They will be embedded, as in the FCS FoS, and will have limited embedded/appended capabilities in non-FCS systems. The end result will be a conglomeration of training systems, creating a LVC-TE with multifunctional and reconfigurable stand alone systems, embedded virtual training systems in FCS-equipped units and limited embedded and appended systems in non-FCS-equipped units. This evolution will lead to virtual training devices that are non-proprietary, highly adaptable solutions with enhanced interoperability capabilities, facilitating enhanced training, mission planning and rehearsals on correlated, geo-specific virtual TDBs.

5.1 The Effects of Technology on Virtual Training Devices

SE Core, OOS, LVC-IA and FCS Spin-Out technologies will have a big impact on virtual training. There are other ongoing programs and science and technology initiatives that will further impact future virtual training. Two programs, Battle Command Knowledge Systems (BCKS) and Advanced Soldier Sensor Information System and Technology (ASSIST), will help virtual simulations better replicate actual mission areas. BCKS will increase the simultaneous visibility and availability of information to a more geographical dispersed and diverse Army. It will accomplish this by using a web-based capability to facilitate the transfer of knowledge from those who have it to those who need it. During operations BCKS will provide Soldiers the means to readily share their knowledge and experiences (e.g., situational awareness) while also providing a means to rapidly retrieve doctrine and knowledge that supports their mission, anywhere in the world. ASSIST will help Soldiers report timely and accurate observations and experiences during ground missions to improve situational understanding. It will use Soldier-worn sensors to augment Soldiers' recall and reporting capabilities and develop information processing and representation tools to maximize the utility of data collected. ASSIST will allow every Soldier to become a sensor.

Working in concert, these two programs will enable Soldiers to update the synthetic environment (e.g., virtual TDBs) in real time as conditions change – enabling the virtual environment to better replicate the mission area in almost real-time. For example, during a mission an enemy force destroys a bridge on a major supply route. Soldiers using Ruggedized Personal Data Assistants (RPDA) photograph and annotate the loss of the bridge and send the information to higher headquarters using web-based capabilities provided by BCKS. This information is sent to a team who updates the synthetic environment, including virtual TDBs and electronic maps in battle command systems, indicating the loss of a bridge. This information can then be used for future mission planning and rehearsals in the LVC-TE.

In addition to using relevant real-world data to update the synthetic environment, future virtual training devices can use augmented reality displays on vehicles (via vision blocks) and on Soldiers (via helmet mounted displays) to enable training with virtual units. Augmented reality displays will present the exact location of virtual models on live terrain of units and Soldiers training in virtual trainers. This capability is enabled using correlated, geo-specific terrain of the mission area. These locations, both virtual and live, will then be sent to Battle Command systems allowing commanders at higher echelons to monitor the training or mission planning and rehearsals.

Figure 4 shows virtual capability trends for the foreseeable future and Figure 5 shows the technology trends that will enable the virtual capability trends. Figure 6 provides two examples of capability trends and their relationship to emerging technology trends. Notice more than one technology trend is required to enable a capability trend.

> • Interoperability, distributed LVC training (JNTC)
> • Expanded battlespace
> • Plug-and-train capabilities
> • Rapidly developed, correlated TDB
> • Archiving: onboard and reach back on demand repositories
> with scenario generation tools and databases (TDB, UOB, TSP)
> • Update synthetic environment in real time
> • Realistic training environment ≈ operational environment
> • Hardware and software supportability
> • Intelligent coach/mentor
> • Language and cultural awareness
> • Scalability
> • Reconfigurable, multifunctional and embedded simulations
> • Multi-level security

TDB-Terrain Database; UOB-Unit Order of Battle; TSP-Training Support Package;
JNTC – Joint National Training Capability

Figure 4: Virtual Capability Trends.

• LVC-IA Standard & Protocols,
• SE Core C4ISR linkages and Common Gunnery Architecture
• SE Core STDGC, RUGUD and Common Moving Models (CM2)
• Joint Training and Experimentation Network (JTEN)
• SE Core Virtual Simulation Architecture (VSA)
• RD3 and LVC-IA repositories and reach-back capability
• SE Core Dynamic terrain & Atmospheric Effects
• Battle Command Knowledge System (BCKS)
• ASSIST (every soldier is a sensor)
• Augmented reality displays
• Gaming technologies/games
• Virtual humans
• FCS embedded training capabilities, NRFTT, PTT
• Bidirectional data guards

CGA-Common Gunnery Architecture; **STDGC**-Standard/Rapid Terrain Database Generation
Capability; **RUGUD**-Rapid Unified Generation of Urban Databases; **NRFTT**-Networkable
Reconfigurable Full Task Trainer; **PTT**-Part Task Trainer; **ASSIST** - Advanced Soldier Sensor
Information System and Technology; **LVC-IA** – Live, Virtual, Constructive – Integrating Architecture

Figure 5: Technology Trends.

CAPABILITY	TECHNOLOGY
• **Realistic training environment ≈ operational environment**	• **SE Core STDGC, CM2 & RUGUD** • **JTEN** • **SE Core dynamic terrain & atmospheric effects** • **BCKS** • **ASSIST** • **Augmented reality display** • **Gaming technologies/games**
• **Intelligent coach/mentor**	• **Augmented reality displays** • **Gaming technologies/games** • **Virtual humans**

Figure 6: Virtual Capabilities/Technology Trends Crosswalk.

The first example in Figure 6 is the capability trend to provide a realistic training environment that closely approximates the operational environment (realistic training environment ≈ operational environment). In order to realize this capability, the virtual training environment must have dynamic terrain and atmospheric effects to provide a more realistic synthetic environment (e.g., destroyed buildings and the show the effects of rain on movement). The virtual training environment needs SE Core's geo-specific TDBs and common moving models made available in the VSA. LVC-IA standards and protocols must be adopted and SE Core C4ISR linkages will be used to populate changes to battle command systems, while using BCKS and ASSIST

to update changes to virtual TDBs in near real time. All this data will move over the JTEN communication backbone. Finally, the virtual synthetic environment will rely on technologies enabled through the gaming industry and augmented reality displays to continually improve the realism of the synthetic environment.

The other example in Figure 6 is intelligent coach/mentor. The principal technology trend to enable this capability trend is virtual humans with artificial intelligence. These virtual humans will be programmed to mentor/coach Soldiers after exercise events and will be capable of responding differently to questions or comments of a participant. The response of the virtual human will be different depending on the grade and responsibility of the Soldier and actions taken during the event. The same question asked by a squad leader may elicit a different response if asked by a platoon leader. Intelligence coach/mentor also leverages gaming technologies and augmented displays to provide better performance and capabilities.

Imagine conducting LVC training in a FCS-equipped BCT. Soldiers in the live environment, either mounted or dismounted, can not only see the live environment, but can also see virtual and constructive entities and command and control information augmented on their helmet mounted displays or vision blocks. Using distributed training over the JTEN, the FCS BCT commander could have one battalion conducting live training at a CTC; one battalion in their motor pool training virtually using their equipment's ET capability; and one battalion staff conducting constructive training at their home station. Subordinate commanders in the BCT not involved in the LVC training can enter the training environment on desk top computers in their office for self development purposes. The FCS BCT commander can direct the operation using battle command systems, regardless of which entity is live, virtual or constructive.

6.0 FUTURE VIRTUAL TRAINING CHARACTERISTICS

Leaders and Soldiers conducting training in the future will not know if entities on their battle command systems are populated from the LVC-TE. The lines between the training domains (i.e., Institutional, Self Development and Operational) and training environments (LVC) will become blurred for commanders conducting training, mission planning or rehearsals on their battle command systems. In addition, the lines between system and non-system virtual TADSS and stand alone, appended or embedded virtual simulations will become blurred. Virtual simulations will use bidirectional data guards to enable multi-level security training capabilities for training in the JIIM environment.

Future virtual simulations will use modular architectures and reconfigure rapidly to replicate a variety of combat systems. Materiel developers for virtual trainers will leverage gaming technologies and Commercial Off-The-Shelf and Governmental Off-The-Shelf solutions to the maximum extent possible in order to increase return on investments for virtual simulations and stay current with the latest commercial gaming capabilities. The materiel developers will also use product line approaches for both software and hardware to lower support costs and increase component reuse. Finally, LVC simulations and instrumentation devices and battle command systems will use rapidly developed, correlated terrain that is geo-specific to the mission or training area and updated in real time. Future training and mission planning and rehearsals will be accomplished from any location at any time using a plug-and-train capability.

6.1 End State: An Updated Vision for Virtual Training

By 2030, a diversely-equipped Army will use a seamless, plug-and-train network of virtual training and battle command systems within an integrated Joint, Live – Virtual – Constructive training environment. This integrated training environment will support requirements to build and sustain unit training, develop flexible, adaptive, and innovative leaders and enable high fidelity mission planning and rehearsals. The objective end state is greater combat readiness and enhanced operational execution.

"Changing the Way We Train"
The Vision For Future Virtual Training
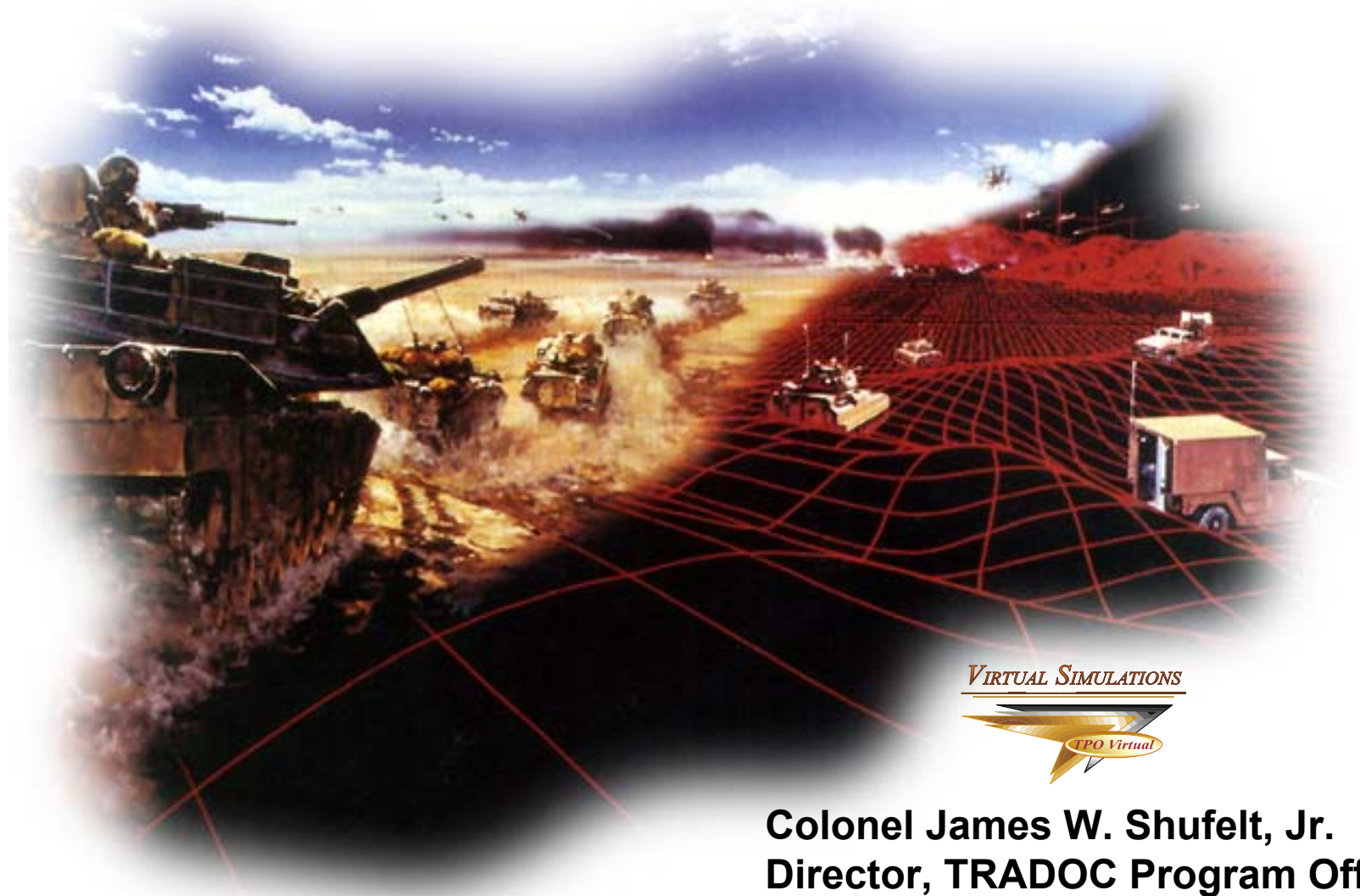
VIRTUAL SIMULATIONS
TPO Virtual

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Virtual Training Environment
15 June 2006

Purpose

To present a proposed updated vision for future Army virtual training

Virtual Training Vision Agents of Change

Current Army Virtual Training Vision

FCS Program (Training KPP)

Army Training Strategies (CATS/ARFORGEN)

Virtual Programs:
-CCTT
-AVCATT
-SE CORE
-Soldier CATT
-EST2000
-CGA/CDT

Updated Army Virtual Training Vision

LVC-IA Concept

OIF/OEF Training Insights/L-L

Joint Training Transformation

Technology Trends

USAF/USN/USMC Training Developments
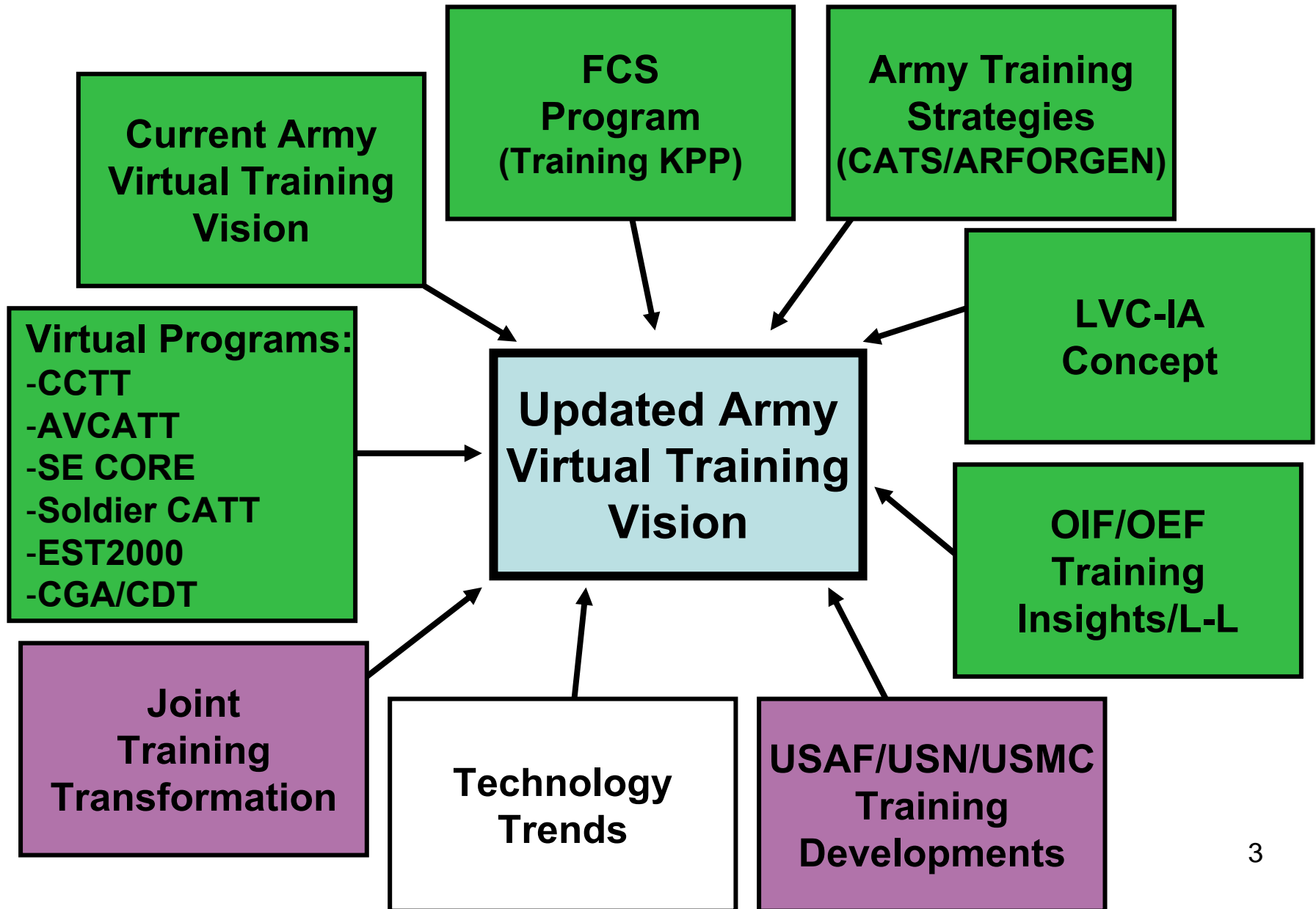
Agenda

- Current virtual vision
- Future Combat System program path
- Live – Virtual – Constructive Integrating Architecture way-ahead
- Virtual training trends/technology
- End state: an updated vision for virtual training

Current Virtual Training System Migration

Current ➞ **Future**

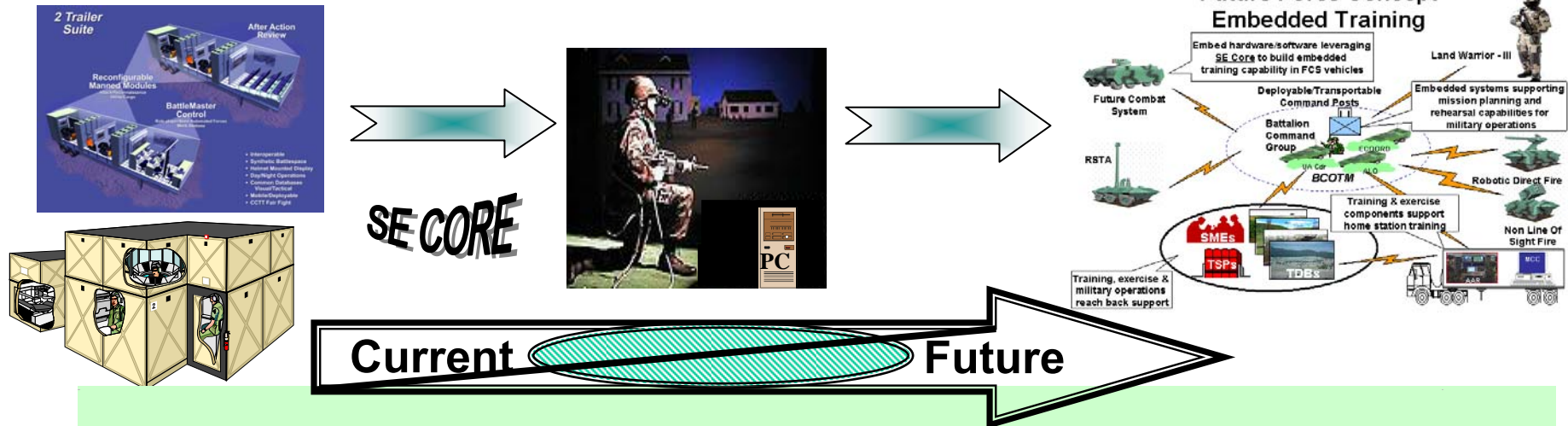|		
Mounted maneuver	**Dismounted Maneuver**	**All combined arms**
Combat operations	**Full-spectrum/COE/JIIM**	**Full-spectrum/COE/JIIM**
Ad hoc L-V-C integration	**Standard L-V-C gateways**	**Seamless L-V-C integration**
Fixed sites	**Portable/deployable/mobile**	**Embedded and deployable**
Standard terrain databases	**Home station, complex terrain and urban operations**	**All terrain; rapid terrain generation**
Analog Linkages	**Digital linkages, FTI**	**Integrated through C4ISR; WAN supports distributed training**
High overhead logistic support	**Reduced logistic support required**	**Deployable w/o logistical support; reach back capability**

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Current Vision for Virtual Training

Evolving Army Transformation

Fully Networked Battle Command capabilities bridge from the Current to Future Force and enable interdependent network-centric warfare

Current → Future

Enhanced Capabilities

Accelerated Development and Fielding

Increasingly:
- *Integrated*
- *Expeditionary*
- *Networked*
- *Decentralized*
- *Adaptable*
- *Decision Superior*
- *Lethal*

Enduring Characteristics of Army Transformation:
Responsiveness, Deployability, Agility, Versatility, Lethality, Survivability, and Sustainability fully support Future Joint Force Attributes

By 2020, Army tactical commanders will use a networked family of virtual training simulations, within an integrated Joint, live - virtual - constructive training environment, to fully support their requirements to build and sustain training, develop leaders and conduct mission rehearsals enabling greater combat readiness.

FCS Training Requirements

Requirement: The FCS FoS must have an embedded individual and collective training capability that supports live, virtual and constructive training environments.

Rationale: Embedded full task and tactical engagement simulation systems provide leaders with a readily available system for training and assessing combat critical skills of Soldiers; and provide the capability to train and assess crew/ sections, dismounted Soldiers, and multi-echelon combined arms skills.

Training KPP Approved by CSA 25 Jan 03

Future Force Concept Embedded Training

Embed hardware/software leveraging **SE Core** to build embedded training capability in FCS vehicles

Future Combat System

Land Warrior - III

Deployable/Transportable Command Posts

Embedded systems supporting mission planning and rehearsal capabilities for military operations

Battalion Command Group

ECOORD

RSTA

UA Cdr

ALO

BCOTM

Robotic Direct Fire

Training & exercise components support home station training

Non Line Of Sight Fire

SMEs

TSPs

TDBs

Training, exercise & military operations reach back support

AAR

MCC

TPIO Virtual is a core member of FCS Training IPT; challenge will be providing accelerated Future Force virtual capabilities to Current Force

FCS Training Concept
Embedded Training

- Full task training capability to support Soldier, crew, small unit including dismounted infantry elements (multi-echelon) training without reconfiguration of the equipment

- Multi-echelon combined arms training for leaders, staff, and units

- Embedded tactical engagement simulation system

- Onboard repository of training products

- AAR, assessment, and learning management system

- Training management system

- Capable of producing computer generated forces

"Instead of UCOFT or CCTT, the crew trains in its own vehicle and whole crew is trained. Training Environment ≈ Operational Environment."

FCS Training Concept
Institutional Training Support

- Establish resource centers at each branch school providing 24/7 training and training support via advanced distributive learning

- Training scenarios tailorable to unit METL

- The ability to combine Live, Virtual, and Constructive operations with computer generated forces to reflect OE

- Linkage to 3D digital terrain sets for training or operations

"ORD requirements give you ET capability"
"Support structure adds seamless LVC linkages and operational reach."

FCS Training Concept
Training Interoperability

- Ensure interoperability with associated FCS networks and information systems must conform to:
  - High Level Architecture
  - Joint Technical Architecture
  - Army Training Information Architecture
  - Common Training Instrumentation Architecture
  - Army Knowledge Enterprise Architecture (AKE)
  - Army Distributive Learning / Shareable Courseware Object Reference Model (SCORM)
- Linkage between Interactive Electronic Technical Manual (IETM) and training development process

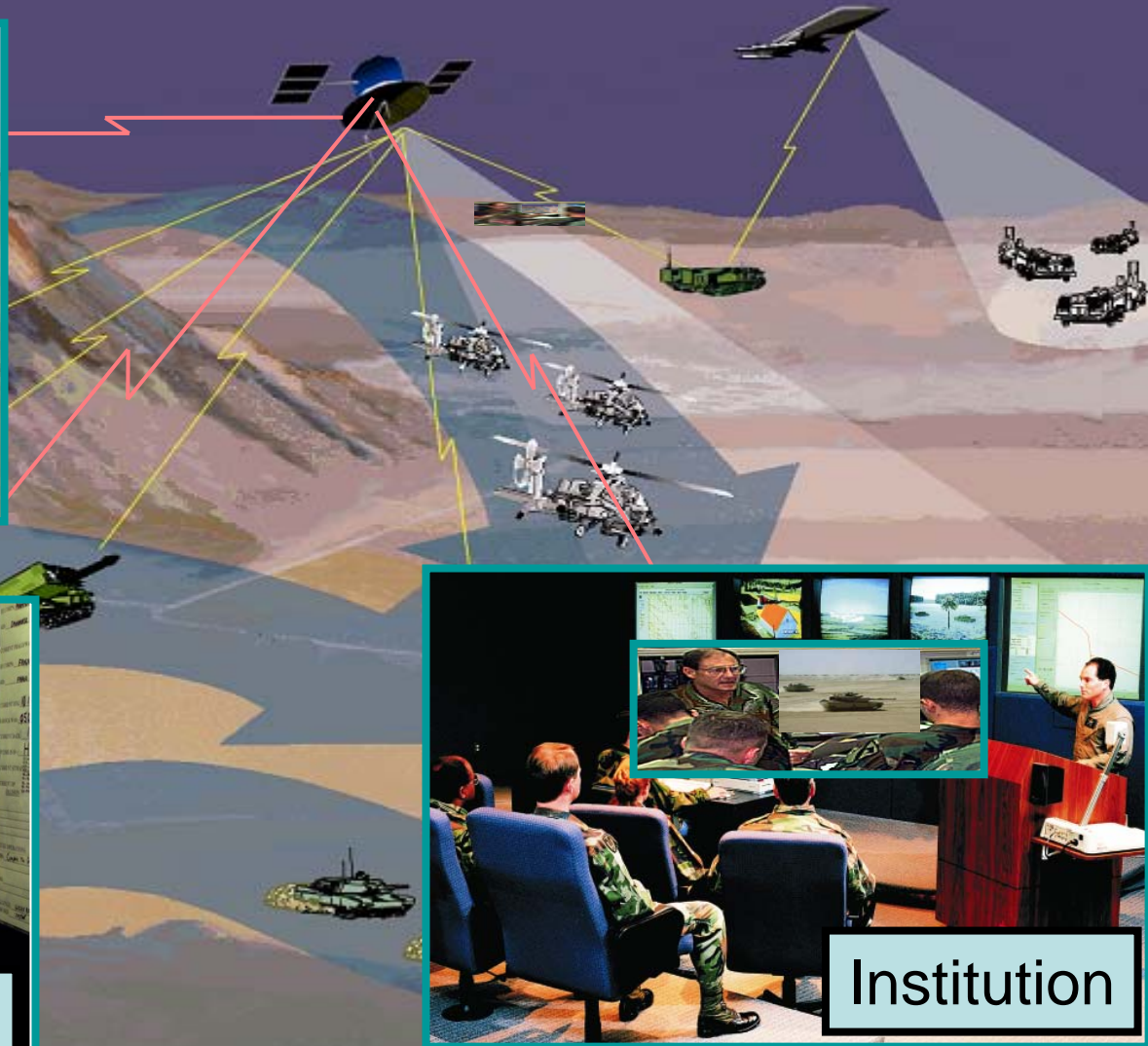**"Add On interoperability costs $ and bandwidth."**

An FCS Objective: Interlinked Training Domains

CTC

HS/D

Institution

Full Spectrum Training

FROM TODAY	SUSTAIN	TO THE FUTURE

FROM TODAY

- Train-Alert-Train-Deploy
- Combined Arms Synchronization
- Forward Deployed
- RC Fully Integrated (Pre & Post Mob)
- CTCs
- Home Station
- Institution
- Threat Based
- Tng Environments (L,V & C)
- Battle Focused Training
- FM 25-100/101

SUSTAIN

Doctrine/Standards Based
→

METL/Battle Focus/CA
→

Realistic, Tough & Demanding Tng
→

Training Domains
→

Tng Environments (L,V & C)
→

OCs/AAR/CALL
→

TTPs
→

TO THE FUTURE

- Train-Alert-Deploy-Employ w/in Emerging OE as CA Team in JIM/SOF
- Strategically Responsive Full Spectrum Ops
- The Decisive Force & JTF Integrator
- Warriors Interlinked, Networked & Joint
- Integrated L-V-C Training, Distributed & Networked through all Domains
- Embedded Training in SoSA
- Capabilities Based
- Application of Emerging Training Technology
- FM 7-0 / 7-1

Training Environment ≈ Operational Environment

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Spin Out 1 - 4 Systems and Capabilities

Objectives for Spin Out #1:
- SoSCOE
- ICS (Integrated Computer System)
- Battle Command
  - UGS/IMS Control
- UGS (Unattended Ground Sensors)
- IMS (Intelligent Munitions System
- NLOS-LS (Non Line of Sight-Launch System)

Prototypes Available in FY 07 – 08
- UGS:
  - T-UGS: Tactical
  - U-UGS: Urban
- IMS
- NLOS-LS

Objectives for Spin Out #2:
- SoSCOE Update
- Battle Command
  - Sensor Management
- Embedded Training
- Communication Relay Payloads

Prototypes Available in FY 09 - 10
- NLOS-C: Non Line of Sight-Cannon
- UAV: Unmanned Aerial Vehicle
  - Class IV
  - Class I
- SUGV: Small Unmanned Ground Vehicle

Objectives for Spin Out #3:
- SoSCOE Update
- Battle Command
- DCGS-A: Distributed Common Ground System-Army

Prototypes Available in FY 11 - 12
- UAV
- ARV: Armed Robotic Vehicle
- ICV: Infantry combat Vehicle
- FRMV: FCS Recovery & Maintenance Vehicle
- Mule: Multi-Functional Utility Logistic Equipment
- NLOS-M: Non Line of Sight-Mortar
- MCS: Mounted Combat System
- RSV: Reconnaissance & Surveillance Vehicle
- NLOS-C: Non Line of Sight-Cannon
- MV: Medical Vehicle
- C2V: Command & Control Vehicle
- UGS: (T-UGS & U-UGS)

Objectives for Spin Out #4:
- SoSCOE Update
- Network Update
- Battle Command
  - SMI (Warfighter Machine Interface)
  - Mission Planning
  - Sustainment Tools

Prototypes Available in FY 13 - 14
- None

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FCS Integration Into Force Structure

End State:
Ground Combat Units – 70
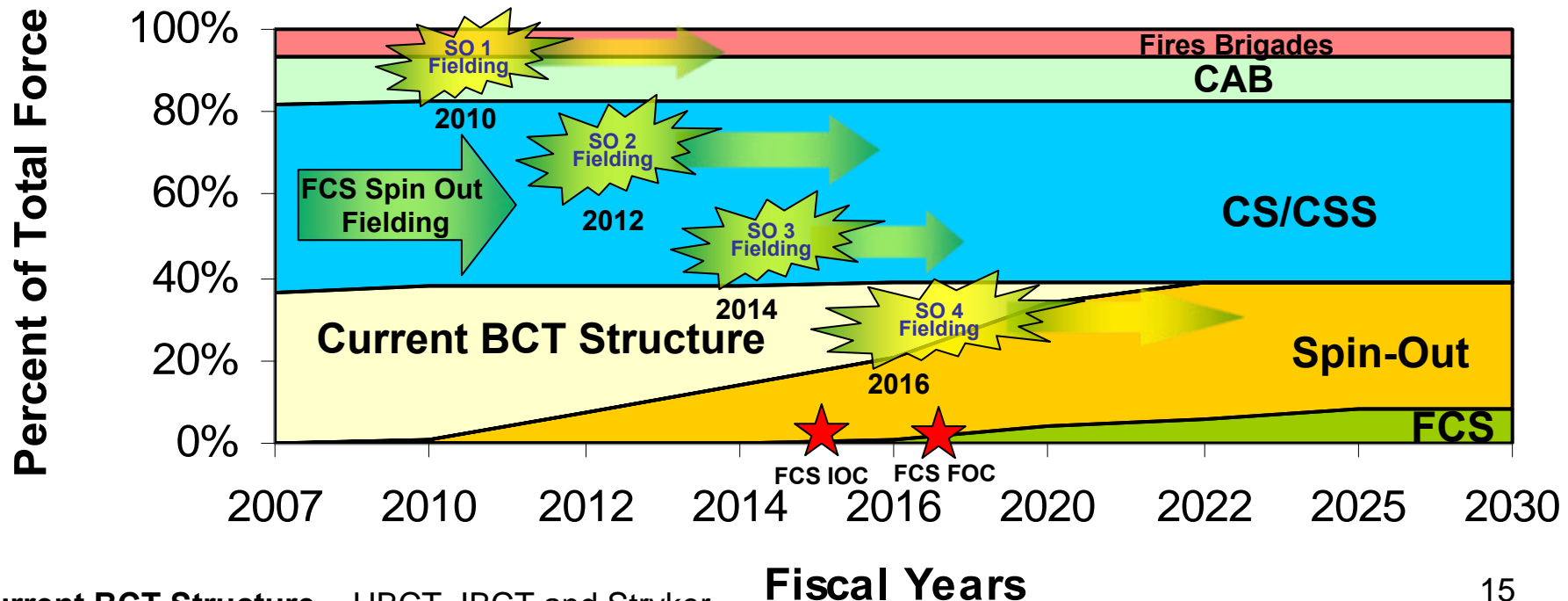 -Spin-Out – 55
  HBCT – 12; IBCT – 36;
  Stryker - 7
 -FCS – 15
CS/CSS Units – 80
Fires Brigades – 12
Combat Aviation Brigades -19

Future Brigade Force Sturcture

Legend: ☐ FCS ☐ Spin Out Brigades ☐ BCT ☐ CS/CSS ☐ CAB ☐ Fires

Y-axis: **Percent of Total Force** — 100%, 80%, 60%, 40%, 20%, 0%

X-axis: **Fiscal Years** — 2007, 2010, 2012, 2014, 2016, 2020, 2022, 2025, 2030

Chart labels:
- SO 1 Fielding — 2010
- SO 2 Fielding — 2012
- SO 3 Fielding — 2014
- SO 4 Fielding — 2016
- FCS Spin Out Fielding
- Current BCT Structure
- Fires Brigades
- CAB
- CS/CSS
- Spin-Out
- FCS
- FCS IOC
- FCS FOC

Current BCT Structure = HBCT, IBCT and Stryker
Spin-Out = HBCT, IBCT and Stryker with Spin Out Technologies

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LVC-IA Training Concept

• Integrate Live, Virtual, & Constructive training environments to create conditions that approximate the operational environment

• Commanders, battle staffs, and units conduct on-demand & distributed mission planning, rehearsals, and training using their unit's integral Battle Command (BC) & Intelligence, Surveillance, Reconnaissance (ISR) systems across the range of military operations (ROMO) in a joint context thereby enhancing readiness

• Increase training effectiveness & efficiency by expanding the battlespace for training and minimizing cost by standardizing hardware, software, and infrastructure between L,V, & C simulations, simulators, & instrumentation

Training Concept IAW LVC-IA ICD dated July 2005

LVC-IA & Infrastructure

LVC Architecture

Interoperability

Common and Reusable Components & Tools

Standardized Communication Protocols

Correlated/Dynamic Synthetic Natural Environment

Data Management

Multi-Level Security

Plug and Train

Enterprise AAR System

Exercise Management

Reach On Demand

Collaborative Exercise Environment

Update Training Support System Products

Integrated LVC Life Cycle Management

Infrastructure

Hardware/Software Supportability

TOC Reduction Initiatives

C4ISR SIM/STIM

Expanded Battlespace

- LVC-IA provides common standards, protocols, & interfaces for L, V, & C TADSS.
- Links to Joint, Service, & COCOM systems are embedded in the requirements above.

LVC Operational View

JIIM
- Joint LVC-TE JCD
- JNTC, Service & SOCOM L, V, & C Simulations, Simulators, & Instrumentation
- TENA

Net Enabled Command Capability (NECC)

FCS -SOSCOE

Army BC & ISR

LIVE - LT2-FTS

OIS

HITS

IMTS

CTIA

OneTESS

NGATS

DMPRC

LVC-IA

VIRTUAL SE Core

Soldier CATT

CCTT

Other Virtual Systems

AVCATT

CONSTRUCTIVE JLCCTC

CBS

DBST

WARSIM

OneSAF

JCATS

CBCSE

LogFED

TACSIM

NWARS

Legend:
C4ISR Sim/Stim
Joint LVC Linkage
LVC Linkage

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SYNTHETIC ENVIRONMENT CORE
(SE CORE)

- Overarching Strategy and Virtual Simulation Products
- Integrated/Interoperable Products and Reuse
- Objective OneSAF Integration
- Live, Virtual, Constructive Integration
- Rapid Terrain Generation

Soldier CATT

FUTURE COMBAT SYSTEMS
FCS
One Team–The Army/Defense/Industry

Embedded Training

Aircraft Concurrency Simulator Upgrades

Live TOCs C4ISR

DBST OneSAF WARSIM

AVCATT
AVCATT-A

Live, Virtual, Constructive Integration

Continuous
SE Core: SAF, AAR, TSP, TDBs, Network, Algorithms
Functionality & Capability Growth

CCTT

M2A2/ODS/A3

Stryker Reconfiguable Simulators

Joint/ Combined Training Systems

M1A1/A2/SEP

Leverage and Expand Investments in a Common Virtual Simulation Environment to Support Army Transformation.

Virtual Capability Trends

- Interoperability, distributed LVC training (JNTC)
- Expanded battlespace
- Plug-and-train capabilities
- Rapidly developed, correlated TDB
- Archiving: onboard and reach back on demand repositories with scenario generation tools and databases (TDB, UOB, TSP)
- Update synthetic environment in real time
- Realistic training environment ≈ operational environment
- Hardware and software supportability
- Intelligent coach/mentor
- Language and cultural awareness
- Scalability
- Reconfigurable, multifunctional and embedded simulations
- Multi-level security

TDB-Terrain Database; **UOB**-Unit Order of Battle; **TSP**-Training Support Package;
JNTC – Joint National Training Capability

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Technology Trends

- LVC-IA Standard & Protocols,
- SE Core C4ISR linkages and Common Gunnery Architecture
- SE Core STDGC, RUGUD and Common Moving Models (CM2)
- Joint Training and Experimentation Network (JTEN)
- SE Core Virtual Simulation Architecture (VSA)
- RD3 and LVC-IA repositories and reach-back capability
- SE Core Dynamic terrain & Atmospheric Effects
- Battle Command Knowledge System (BCKS)
- ASSIST (every soldier is a sensor)
- Augmented reality displays
- Gaming technologies/games
- Virtual humans
- FCS embedded training capabilities, NRFTT, PTT
- Bidirectional data guards

CGA-Common Gunnery Architecture; **STDGC**-Standard/Rapid Terrain Database Generation Capability; **RUGUD**-Rapid Unified Generation of Urban Databases; **RD3**-Rapid Distributed Database Development; **NRFTT**-Networkable Reconfigurable Full Task Trainer; **PTT**-Part Task Trainer; **ASSIST** - Advanced Soldier Sensor Information System and Technology; **LVC-IA** – Live, Virtual, Constructive – Integrating Architecture

Virtual Capability/Technology Trend Crosswalk

CAPABILITY	TECHNOLOGY
• Interoperability/distributed LVC training (JNTC)	• LVC-IA Standard & Protocols • SE Core C4ISR linkages, CGA • SE Core STDGC, CM2 & RUGUD • JTEN • SE Core VSA • LVC-IA repositories & reach-back
• Expanded battle space	• LVC-IA Standard & Protocols • SE Core C4ISR linkages, CGA • SE Core STDGC, CM2 & RUGUD • JTEN • SE Core VSA
• Plug-and-train capabilities	• LVC-IA Standard & Protocols • SE Core C4ISR linkages, CGA • SE Core STDGC, CM2 & RUGUD • JTEN • SE Core VSA • LVC-IA Repositories & reach-back

Virtual Capability/Technology Trend Crosswalk

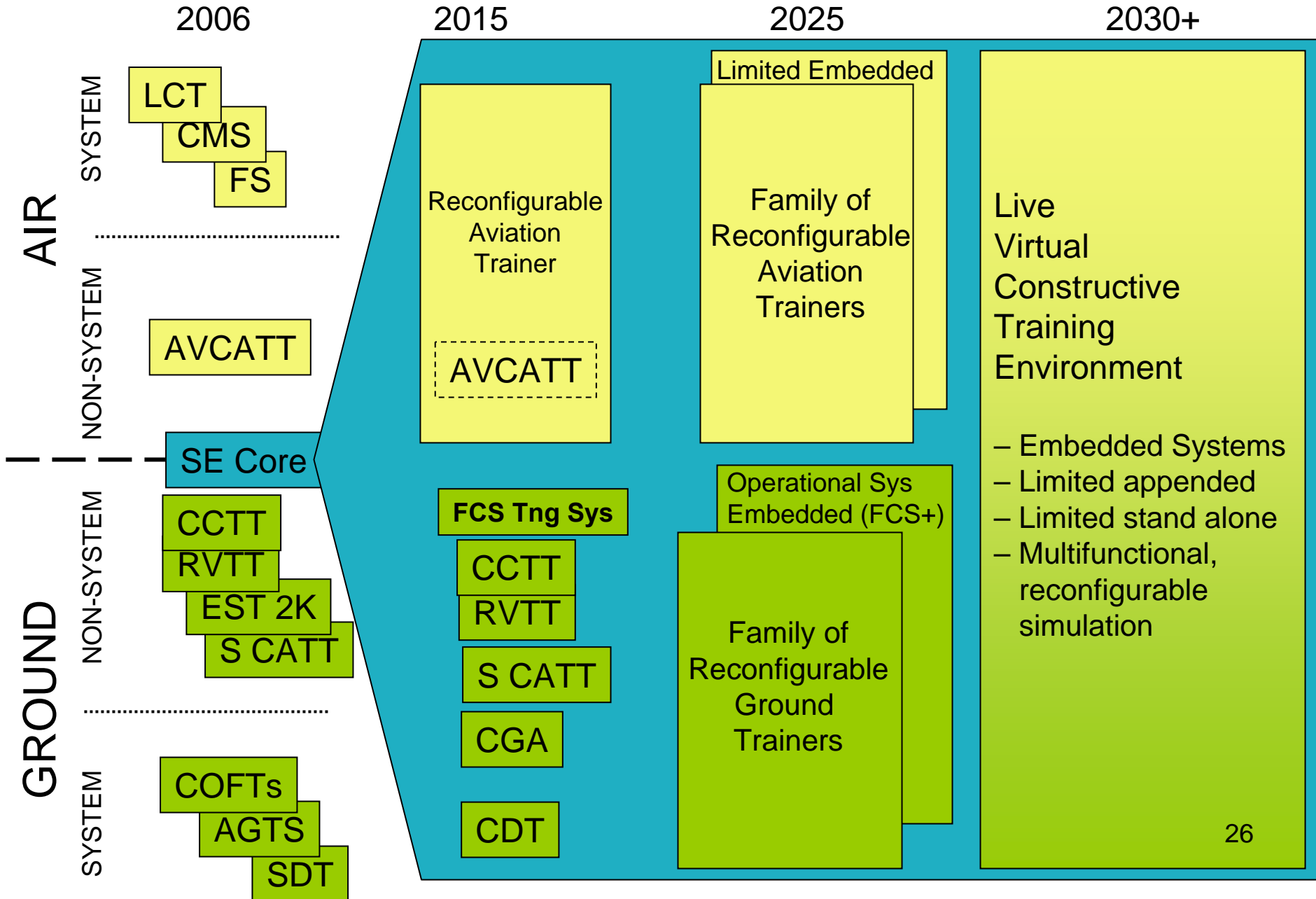| CAPABILITY	TECHNOLOGY
• **Rapidly developed, correlated TDB**	• **SE Core STDGC, CM2 & RUGUD** • **JTEN** • **SE Core VSA** • **LVC-IA repositories & reach-back**
• **Archiving: onboard and reach back on demand repositories with scenario generation tools and databases (TDB, UOB, TSP)**	• **LVC-IA Standard & Protocols** • **JTEN** • **SE Core VSA** • **LVC-IA repositories and reach-back**
• **Update synthetic environment in real time**	• **SE Core dynamic terrain & atmospheric effects** • **BCKS** • **ASSIST** • **JTEN**

Virtual Capability/Technology Trend Crosswalk

CAPABILITY	TECHNOLOGY
• **Realistic training environment ≈ operational environment**	• **SE Core STDGC, CM2 & RUGUD** • **JTEN** • **SE Core dynamic terrain & atmospheric effects** • **BCKS** • **ASSIST** • **Augmented reality display** • **Gaming technologies/games**
• **Hardware and software supportability**	• **LVC-IA Standard & Protocols** • **SE Core STDGC, CM2 & RUGUD** • **SE Core VSA** • **Gaming technologies/games**
• **Intelligent coach/mentor**	• **Augmented reality displays** • **Gaming technologies/games** • **Virtual humans**

Virtual Capability/Technology Trend Crosswalk

CAPABILITY	TECHNOLOGY
• Language and cultural awareness	• SE Core STDGC, RUGUD, CM2 • Augmented reality displays • Gaming technologies/games • Virtual humans
• Scalability	• LVC-IA Standard & Protocols • SE Core STDGC, CM2 & RUGUD • LVC-IA repositories and reach-back • Gaming technologies/games
• Reconfigurable, multifunctional and embedded simulations	• Augmented reality displays • Gaming technologies/games • FCS embedded training, NRFTT, PTT
• Multi-level security	• Bidirectional data guards

A Theoretical Virtual Roadmap to the Future

| 2006 | 2015 | 2025 | 2030+ |

AIR

SYSTEM
- LCT
- CMS
- FS

NON-SYSTEM
- AVCATT

GROUND

SE Core

NON-SYSTEM
- CCTT
- RVTT
- EST 2K
- S CATT

SYSTEM
- COFTs
- AGTS
- SDT

2015

Reconfigurable Aviation Trainer

AVCATT

FCS Tng Sys
- CCTT
- RVTT
- S CATT
- CGA
- CDT

2025

Limited Embedded

Family of Reconfigurable Aviation Trainers

Operational Sys Embedded (FCS+)

Family of Reconfigurable Ground Trainers

2030+

Live Virtual Constructive Training Environment

– Embedded Systems
– Limited appended
– Limited stand alone
– Multifunctional, reconfigurable simulation

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End State – A New Vision for Virtual Training (2030)

- **Expanded and Blended Training Audience**
  - FCS embedded, NRFTT & PTT
  - Embedded training and spin out technologies into current combat systems
  - CS/CSS units
  - Field Artillery/Fires units and Combat Aviation Brigades (CABs)
- **Line between virtual and constructive training blurred**
- **Line between operational, unit training and institution blurred**
- **Line between system and non-system devices blurred**
- **Line between command & control and training systems blurred**
- **Rapidly reconfigurable hardware**
- **Modular architectures**
- **Multi-level security capability**
- **Maximize use of COTS & GOTS solutions**
- **Product line approach (common hardware and software to maximum extent)**
- **Rapidly developed, correlated terrain databases consumable by LVC training environment and battle command systems**

New Vision for Virtual Training: By 2030, a diversely-equipped Army will use a seamless, plug-and-train network of virtual training and battle command systems within an integrated Joint, Live – Virtual – Constructive training systems environment. This integrated training environment will support the requirements to build and sustain unit training, develop flexible, adaptive, and innovative leaders and enable high fidelity mission planning and rehearsals. The objective end state is greater combat readiness and enhanced operational execution.

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